

(1)

# Problem Set #5

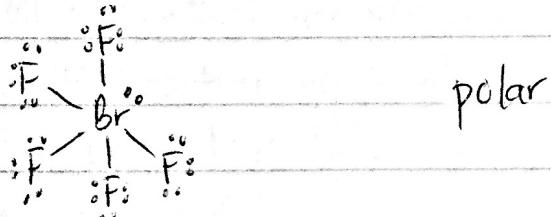
CHM129

(1) (a)  $\text{CS}_2$ 

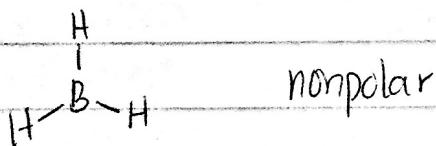
$$ve = 4e^- + 2(6e^-) = 16e^-$$

(b)  $\text{BrF}_5$ 

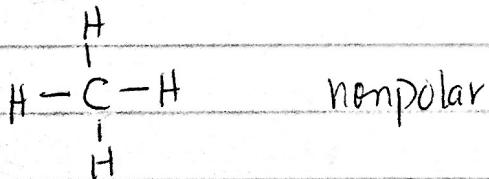
$$ve = 7e^- + 5(7e^-) = 42e^-$$

(c)  $\text{BH}_3$ 

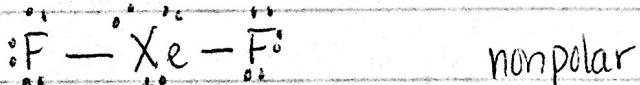
$$ve = 3e^- + 3(1e^-) = 6e^-$$

(d)  $\text{CH}_4$ 

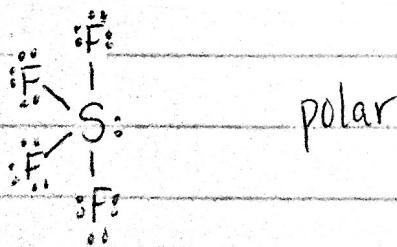
$$ve = 4e^- + 4(1e^-) = 8e^-$$

(e)  $\text{XeF}_2$ 

$$ve = 8e^- + 2(7e^-) = 22e^-$$

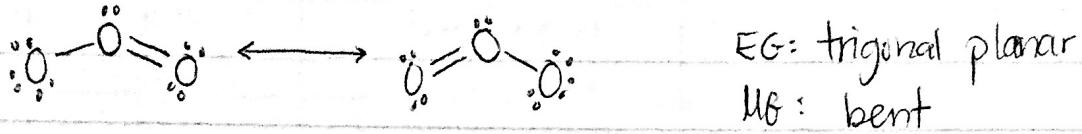
(f)  $\text{SF}_4$ 

$$ve = 6e^- + 4(7e^-) = 34e^-$$

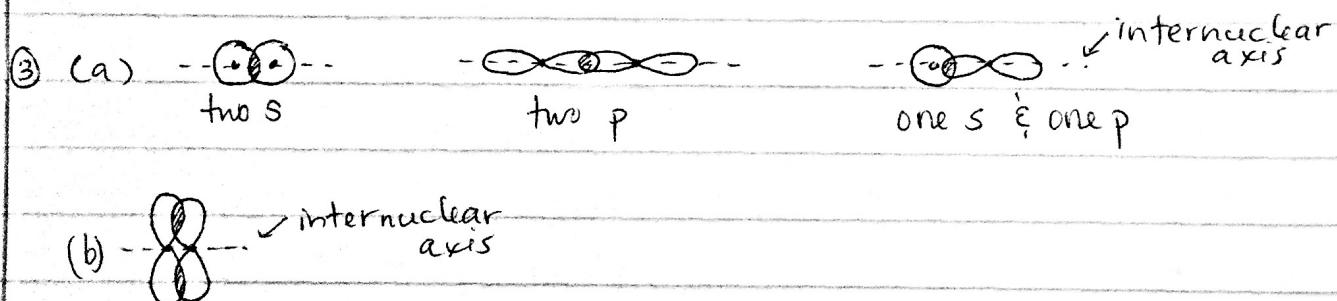


(2)

$$\textcircled{2} \quad \text{O}_3 \quad \text{ve} = 3(6e^-) = 18e^- \quad \text{dipole moment} = 0.53 \text{ D}$$



Since all the atoms are the same, the individual bonds are nonpolar. However, the central oxygen atom has a lone pair of electrons which cause an unequal electron (and charge) distribution in the molecule. This lone pair is the source of the dipole moment in  $\text{O}_3$ .



(c) A  $\sigma$  bond is generally stronger than a  $\pi$  bond because there is more extensive overlap.

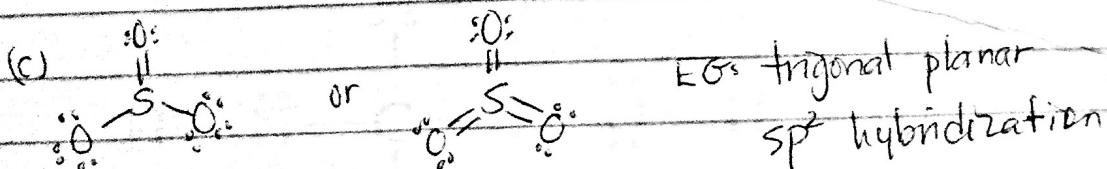
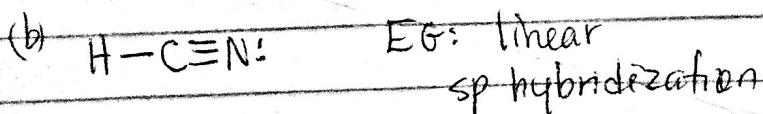
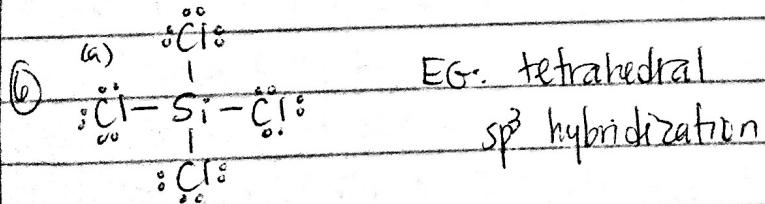
(d) Two s orbitals cannot form a  $\pi$  bond. A  $\pi$  bond has no electron density along the internuclear axis. Overlap of s orbitals results in electron density along the internuclear axis (s orbitals have wrong symmetry to form a  $\pi$  bond).

(4)

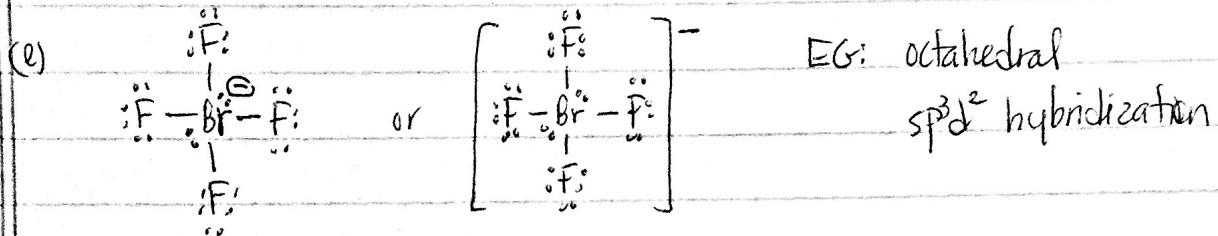
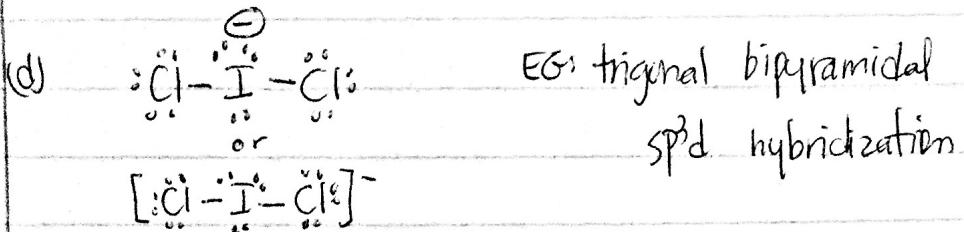
Answers may  
vary

Molecule	Electron-Group Geometry	Hybridization of Central Atom	Polar? Yes or No.
CO <sub>2</sub>	linear	sp	no
NH <sub>3</sub>	tetrahedral	sp <sup>3</sup>	yes
CCl <sub>4</sub>	tetrahedral	sp <sup>3</sup>	no
BH <sub>3</sub>	trigonal planar	sp <sup>2</sup>	no
SF <sub>4</sub>	trigonal bipyramidal	sp <sup>3</sup> d	yes
SF <sub>6</sub>	octahedral	sp <sup>3</sup> d <sup>2</sup>	no
SO <sub>2</sub>	trigonal planar	sp <sup>2</sup>	yes
PF <sub>5</sub>	trigonal bipyramidal	sp <sup>3</sup> d <sup>1</sup>	no
XeF <sub>2</sub>	trigonal bipyramidal	sp <sup>3</sup> d	no

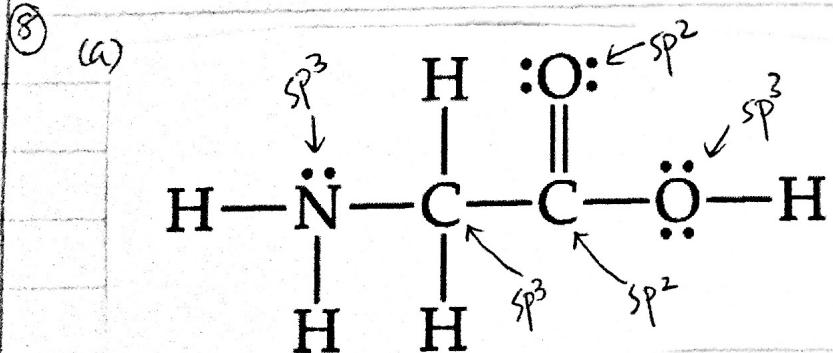
- ⑤ In order for atomic orbitals to mix or hybridize, they must have the same principal quantum number. In each shell, there are a maximum of three p orbitals. Any hybrid orbital can have a contribution from a maximum of three p orbitals. Hybrid orbitals designated sp<sup>4</sup> or sp<sup>5</sup> would require contribution from 4 or 5 p orbitals, which is not possible.



4



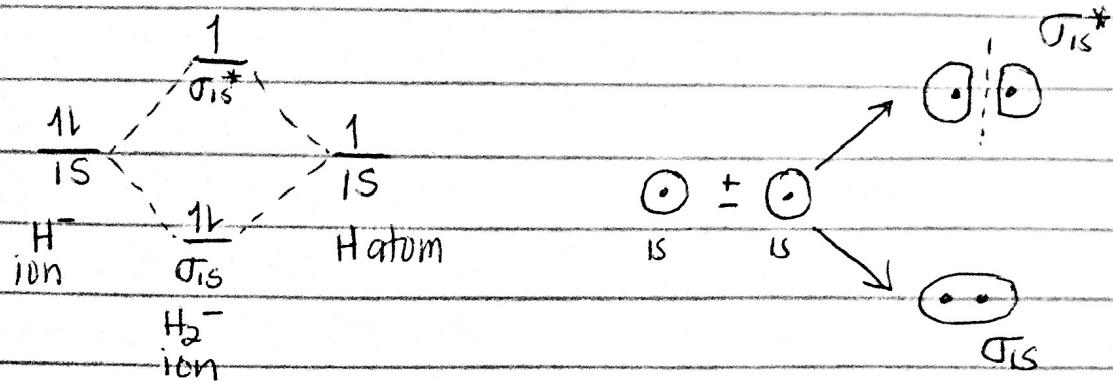
(c) N<sub>2</sub> bond is a triple bond so it is significantly stronger (than N<sub>2</sub>H<sub>4</sub> bond) because it consists of a σ bond & two π bonds (N<sub>2</sub>H<sub>4</sub> consists of a σ bond only). The additional overlap of the two π bonds adds to the strength of the N-N bond in N<sub>2</sub>.



(b) 9  $\sigma$  bonds  
and 1  $\pi$  bond.

(5)

(9) (a)



$$(b) \sigma_{IS}^2 \sigma_{IS}^{*1}$$

$$(c) B.O. = \frac{1}{2} (2-1) = \frac{1}{2}$$